LAKE MEAD NATIONAL RECREATION AREA
GEOLOGIC RESOURCES MANAGEMENT ISSUES
SCOPING SUMMARY
(Revised)

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Revised: November 2, 2004

Executive Summary

A Geologic Resources Inventory (GRI) workshop was held for Lake Mead National Recreation Area (LAME) on February 13, 2002. The purposes of the workshop were: (1) to view and discuss the geologic resources of the park; (2) to address the status of geologic mapping for compiling both paper and digital maps; and, (3) to assess resource management issues and needs. Cooperators from the NPS Geologic Resources Division (GRD), LAME, and the United States Geologic Survey (USGS) were present for the workshop.

The workshop involved field trips to various points of interest in LAME, led by Bill Burke (LAME) and Sue Beard (USGS), as well as another half-day scoping session to present overviews of the NPS Inventory and Monitoring (I&M) program, GRD, and the on-going GRI program. Round table discussions involving geologic issues for LAME included the status of geologic mapping efforts, interpretation, sources of available data, and action items generated from this meeting. For a list of meeting attendees, see Appendix A (List of Cooperators for Lake Mead NP GRI Workshop, February 13, 2002).

Introduction

The NPS GRI has the following goals for some 273 units with significant natural resources:
1) To assemble a bibliography (GRBIB) of known geological publications to compile and evaluate a list of existing geologic maps for each unit,
2) To conduct a scoping session for each park,
3) To develop digital geologic map products for use in a GIS (geographic information system); and,
4) To complete a geologic report that synthesizes much of the existing geologic knowledge about each park.

The emphasis of the inventory is not to routinely initiate new geologic mapping projects, but to aggregate existing “baseline” information and identify where serious geologic data needs and issues exist in the National Park System. For those NPS units where map coverage is nearly complete or where maps simply do not exist, funding may be available for geologic mapping.

After introductions by the participants, Bruce Heise (NPS-GRD) presented overviews of the Geologic Resources Division, the NPS I&M Program, the status of the Natural Resource Inventories, and the Geologic Resource Inventory in particular.

Tim Connors (NPS-NRID) presented a demonstration of some of the main features of the digital geologic database for the Black Canyon of the Gunnison NP and Curecanti NRA in Colorado. This has become the prototype for the NPS digital geologic map model as it reproduces all aspects of a paper map (including map notes, cross sections, legend etc.) with the added benefit of being geospatially referenced. It is displayed in ESRI ArcView shape files and features a built-in Microsoft Windows help file system to identify the map units. It can also display scanned JPG or GIF images of the geologic cross sections supplied with the paper (analog) map. Geologic cross section lines are subsequently digitized as a line coverage and are hyperlinks to the scanned images.

GRBIB

At the scoping session, the GRI staff provided geologic bibliographies for LAME in Microsoft Word format. The sources for information are: (1) The AGI (American Geological Institute) GeoRef; (2) the USGS GeoIndex; and, (3) ProCite information taken from the libraries of specific NPS units. These bibliographic compilations were validated by GRI staff to eliminate duplicate citations, typographical errors, and as well as to check for applicability to the specific park. After validation, they become part of a Microsoft Access database parsed into columns based on park, author, year of publication, title, publisher, publication number, and a miscellaneous column for notes.

For the Access database, they are exported as Microsoft Word Documents for easier readability, and eventually turned into PDF documents. They are then posted to the GRI website at: http://www2.nature.nps.gov/grd/geology/gri/products/geobib/ for general viewing.

Existing Geologic Maps

There are 120 quads of interest for LAME. Additionally, after the bibliographies were assembled, a separate search was made for any existing surficial and bedrock geologic maps for LAME. (See Appendix B, LAME Quadrangles of Interest)

Maps at 1:125,000 scale

USGS Professional Paper 374-E (Reconnaissance Geology between Lake Mead and Davis Dam, Arizona-Nevada by Chester R. Longwell) contains a geologic map covering much of LAME at the 1:125,000 scale (Plate 1; *Geologic Map and Sections of area along Colorado River between Lake Mead and Davis Dam, Arizona and Nevada*). However, there are a few drawbacks with this map. It is not known if there is enough detail on this map because of the scale, and it is not certain if it contains the most recently accepted stratigraphic nomenclature, since it was published in 1963. Also, it is not known if it exists in a digital format (See Appendix C, LAME Geologic Maps: 125,000 scale).

Maps at 1:100,000 scale

Lake Mead is a large park and its boundaries are contained on numerous USGS 1:100,000 scale maps for Nevada (north to south: Lake Mead, Boulder City, and Davis Dam). The Arizona portions of Lake Mead, Parashant National Monument, and portions of Grand Canyon National Park are contained on the following 1:100,000 scale sheets, from north to south: Littlefield, Mount Trumbull and Peach Springs (see Appendix D, LAME Geologic Maps: 1:100,000 scale).

During the scoping session, discussions centered on the current USGS project to complete the Lake Mead 1:100,000 sheet. The NPS-GRI program has contributed up to $20,000 to help facilitate completion of this project, which was undertaken by the USGS in conjunction with their mapping of the Las Vegas 1:100,000 sheet. Sue Beard and others are working on this project, and it is nearing completion. The map was in a “preliminary” digital format at the time of the scoping meeting, complete with coverages of the geologic units, geologic contacts, faults, annotations, attitudes, etc. Sue said the NPS could have a digital copy now and begin using the data. However, this is with the understanding that some of the map unit descriptions need to be finalized, the metadata is incomplete, and the surficial geology could use some refinement in the future Also, Sue is waiting for Argon-49 dates from the USGS in Denver. She said the USGS plans to release the Lake Mead sheet either in "I-Map" series or as a miscellaneous folio report.

The USGS has also produced a geologic map for the Littlefield 1:100,000 sheet (Geologic Investigations Series Map I–2628, Geologic Map of the Littlefield 30' x 60' Quadrangle, Mojave County, Northwestern Arizona by George H. Billingsley and Jeremiah B. Workman; available at http://geopubs.wr.usgs.gov/i-map/i2628/). Also, the Grand Canyon 1:100,000 sheet is published (Geologic Map of the Grand Canyon 30' x 60' Quadrangle, Coconino and Mohave Counties, Northwestern Arizona, By George H. Billingsley) at http://pubs.usgs.gov/imap/2000/i-2688/

The USGS also has the following publications in the works and nearing completion at the 1:100,000 scale: Las Vegas, Mount Trumbull, Peach Springs, and Lake Mead. It is not known if the USGS plans to assemble the Overton, Boulder City, and Davis Dam 1:100,000 sheets at this time.

Maps at 1:62,500 scale

There is coverage at the 1:62,500 scale in the following maps that cover the LAME area in portions of the Boulder City 1:100,000 sheet:

- GQ-1394: Anderson, R. Ernest, 1978, Geologic map of the Black Canyon 15-minute quadrangle, Mohave County, Arizona, and Clark County, Nevada, US Geological Survey, GQ-1394, scale 1:62500.

- GQ-1395: Anderson, R. Ernest, 1977, Geologic map of the Boulder City 15-minute quadrangle, Clark County, Nevada, US Geological Survey, GQ-1395, scale 1:62500.

It is not known if these 1:62,500 scale maps exist in a digital format. See Appendix E, LAME Geologic Maps 1:62,500 scale, for a graphical representation of the area covered on these maps These maps were scanned and georeferenced by the NPS.

Maps at 1:24,000 scale

There are 1:24,000 scale geologic maps known to cover the quadrangles of interest for LAME. For simplicity sake and because the Lake Mead 1:100,000 sheet incorporates much of this work, the 1:24,000 maps encompassed in the Lake Mead 1:100,000 are ***not*** mentioned below (See Appendix F, LAME Geologic Maps: 24,000 scale)

OVERTON 1:100,000 sheet

- Hoover, D.L., Bohannon, R.G., and Simonds, F.W., 1992, Preliminary geologic map of the Riverside quadrangle, Clark County, Nevada, U.S. Geological Survey, OF-92-554, scale 1:24000.

- Beard, L.S., 1993, Preliminary geologic map of the Whitney Pocket 7.5 minute quadrangle, Clark County, Nevada, U.S. Geological Survey, OF-93-716, scale 1:24000.

- Bohannon, R.G., 1992, Geologic map of the Weiser Ridge quadrangle, Clark County, Nevada, U.S. Geological Survey, GQ-1714, scale 1:24000.

<u>LAS VEGAS 1:100,000 sheet</u>

- Lundstrom, S.C., Page, W.R., Langenheim, V.E., Young, O.D., and Mahan, S.A., 1998, Preliminary geologic map of the Valley quadrangle, Clark County, Nevada, U.S. Geological Survey, OF-98-508, scale 1:24000.

- Matti, J.C. and Morton, D.M., 1982, Preliminary geologic map of the Las Vegas NE quadrangle, Nevada Bureau of Mines and Geology, OF 82-5, scale 1:24000.

- Bingler, E.C., 1977, Geologic Map, Las Vegas SE quadrangle, Las Vegas Area, Nevada, Nevada Bureau of Mines and Geology, Urban Map 3Ag, scale 1:24000.

<u>BOULDER CITY 1:100,000 sheet</u>

- Faulds, J.E., 1996, Geologic Map of the Fire Mountain quadrangle, Nevada and Arizona, Nevada Bureau of Mines and Geology, Map 106, scale 1:24000.

- Faulds, J.E., 1995, Geologic Map of the Mount Davis quadrangle, Nevada and Arizona, Nevada Bureau of Mines and Geology, Map 105, scale 1:24000.

- Faulds, J.E. and Bell, J.W., 1999, Geology of the Nelson Southwest Quadrangle, Nevada, Nevada Bureau of Mines and Geology, OF 99-15, scale 1:24000.

<u>LARGE SCALE MAPS (>24,000 scale)</u>

There is a miscellaneous large scale map for the area:
Sewall, A.J. and Duebendorfer, E.M., 1989, Geologic map of Saddle Island, Lake Mead, Nevada, Geological Society of America, Memoir 176, scale 1:6,000 scale.

<u>Additional Issues Pertaining to Geologic Mapping and Research</u>

Bill Burke, Natural Resource Specialist at LAME, would like to see a geologic map for LAME that covers the entire watershed boundary extending from the Eldorado Mountains to the Black Mountains. During the scoping session, it was suggested that Jim Faulds with the Nevada Bureau of Mines and Geology should have been invited to this scoping session because of his mapping activities in the southern portion of LAME. Tim Connors is still waiting to hear back from him for his knowledge of existing maps in the southern portion, their quality, and if they are digital or not. More details will be supplied as they become available.

Burke would also like a paleontological inventory done for the park to get a better idea of these resources the park may be charged with preserving. GRD is available to assist parks with these requests for inventories. The park contains rocks from the Paleozoic, Mesozoic and Cenozoic eras, and the likelihood for paleontological resources is high. Also, there is a mammoth site, and tusks have been found in the park, as well as petrified wood and camel tracks. Sue Beard mentioned that two mammoths have been recovered in the park along the shoreline of the lake.

Kent Turner (LAME) is interested in developing the relationship between soils and geology for the purpose of deriving vulnerability and recoverability maps for ecosystem recovery in disturbed land areas. Pete Biggam (NPS Soils Inventory Coordinator) says that final soils maps should be delivered by the NRCS in the near future. The Nevada portion is already complete according to Kent.

Kent is also interested in studies of the relationships of natural springs in the park to other natural resources such as species distributions, natural plant communities, oak trees, etc. He says that the NPS-Water Resources Division is currently working on this.

The park has a thorough GIS layer for abandoned mines created by Bill Burke and Jonathan Lee that should be incorporated into the geologic maps. Also, Brian Moore (NPS-JOTR) was mentioned as having an access database of all surveying done for the AML features and point locations that could also be incorporated into the geologic digital layer. Mark Sappington (USGS at UNLV) was mentioned as the person who has been assisting LAME with their GIS since John Lee left the park and should be consulted for any existing digital geology for the region.

Sue Beard stated that Simon Hook (Jet Propulsion Lab) has been flying TIMS coverages of the region. This produces high resolution airborne mapping useful in geology and soils mapping. Apparently there is complete coverage for the LAME area. These maps have been useful for discerning mineralogy (e.g. (quartz, carbonate, etc.) at the surface and would likely be very useful for resource managers in the NPS

<u>Geologic Reports</u>

Sue Beard indicated that John Bezy has published a layman's guide to the geology of LAME (Bezy, John V., *A Guide to the Desert Geology of Lake Mead National Recreation Area*).

Also, "Geologic Tours in the Las Vegas Area (expanded edition) by Nevada Bureau of Mines and Geology, Special Publication 16" is an excellent reference for geology of the Lake Mead region.

<u>Interpretation</u>

Melanie Moreno (USGS-Menlo Park) worked with the NPS to create a page on the geology of Lake Mead NRA; it is located at http://www2.nature.nps.gov/grd/usgsnps/lmnra/lmnra1.html . During the scoping session, park resource managers showed interest in using the geologic maps for various interpretive examples throughout the park.

Physiography

Lake Mead National Recreation Area spans two physiographic provinces, the Basin and Range and the Colorado Plateau. Most of the NRA, including Lake Mead and Lake Mohave, lies in the Basin and Range. The detached Arizona portion is on the Colorado Plateau and has the characteristics of the Grand Canyon. In the north part of the Nevada portion, are the Black Mountain and the Muddy Mountains. Muddy Peak, outside the park boundary is at 5,432 feet. The elevation of the water level in Lake Mead varies, but the average from 1939 to 2003 has been 1,176 feet. In 2003, the average was 1,143 feet. To the south, the Colorado River and Lake Mohave are east of the Eldorado and Newberry Mountains. Spirit Mountain in the Newberry

Mountains is at 5,639 feet and the elevation of Lake Mohave is below the 800-foot contour. North of the Grand Canyon, Andrus Point is at 5,491 feet and north of Andrus Point the elevation is over 5600 feet.

Geology

Arizona Colorado Plateau

The Colorado Plateau portion of Lake Mead NRA lies on the Shivwits Plateau, the westernmost plateau of the Colorado Plateau physiographic province. It is physiographically and stratigraphically typical of the Grand Canyon region. The Shivwits Plateau is bounded on the east by the Hurricane Cliffs which separates it from the Uinkaret Plateau to the east. To the west, it is bounded by the Grand Wash Cliffs which form the eastern border of the Basin and Range physiographic province. It extends north to the St. George Basin in Utah and south to the Colorado River which forms the very rugged and precipitous topography of the Grand Canyon. The Shivwits Plateau is mostly rolling dissected tableland and lava-capped buttes

The Hurricane Cliffs and the Grand Wash Cliffs are structural features formed by the Hurricane and Grand Wash faults respectively. These are high-angle, normal faults with the greatest movement along the dip face, down-thrown to the west. Both of these major faults trend north-south and extend for hundreds of miles. Displacements are on the order of thousands of feet, decreasing to the south on the Hurricane Fault and decreasing to the north on the Grand Wash Fault. Movement along both these faults began in the Miocene and continued into the Pliocene on the Grand Wash fault and into the Holocene on the Hurricane fault. Other faults in the area are mostly high-angle, dip-slip with some scissor component. These trend generally north-south and produce a series of grabens. The Shivwits Plateau is underlain by Paleozoic strata dipping 2 to 5 degrees to the northeast.

Much of the Shivwits Plateau is capped by the Kaibab Limestone of Upper Permian age. The stratigraphy ranges in age from Precambrian to Middle Jurassic. The Precambrian is exposed along the Colorado River between the junction with Whitmore and Parashant Canyons. The Cambrian is represented by the Tonto Group, consisting of about 150 feet of Tapeats Sandstone, 400 feet of Bright Angel Shale, 670 feet of Mauv Limestone, and 221 feet of an unnamed dolostone. The Ordovician and Silurian periods are not represented in the Shivwits Plateau. The Devonian is represented by the Temple Butte Limestone.

The Mississippian Redwall Limestone is one of the most prominent formations in northern Arizona and is equivalent to the Leadville Limestone in Colorado. The Redwall Limestone forms shear cliffs over 600 feet high. In Parashant Canyon McKee and Gutschick (1969) described the Redwall as consisting of four members. The stratigraphically lowest member is the Whitmore Wash Member, the type area in Whitmore Wash southeast of Mt. Trumbull. It thins to the east, from 200+ feet at Iceberg Canyon near the Arizona-Nevada border to 70-80 feet in the eastern Grand Canyon. It consists of thick-bedded, gray, fine-grained limestone, locally grading to into dolostone and rests unconformably on the Temple Butte Limestone. The upper limit is defined by thin chert beds alternating with limestone in the Thunder Springs Member. The Thunder Springs Member is 138 feet thick at the type area on the Thunder River Trail. The overlying Mooney Falls Member is the most consistent cliff-former of the Redwall. It is composed of mostly light olive-gray, coarse-grained limestone with crinoid joints. An upper thin chert layer is white, thin-bedded, alternating with thin-bedded limestone. It pinches out laterally from a maximum of 3 feet thick. The uppermost unit is the Horseshoe Mesa Member. It consists of gray, fine-grained, thick-bedded limestone. The lower half forms a massive cliff and the upper half weathers to receding step-like ledges at the top of Parashant Canyon.

Above the Redwall Limestone is the Supai Group of Pennsylvanian-Permian age. In LAME the Supai Group consists of a basal, dark-brown, massive conglomerate. Clasts consist mostly of well-rounded jasper and chert and range up to 6 inches in diameter. Above this basal conglomerate, is a sequence of gray to pink limestone, siltstone, and sandstone 280 to 425 feet thick, capped by 330-560 feet of pinkish-gray to light-red, fine-grained sandstone. The sandstone, composed of well-sorted, rounded quartz grains, is massive with extensive cross-bedding. In many references the lower conglomerate and limestone are called the Callville Limestone of Pennsylvanian age and the upper massive sandstone is the Permian Esplanade Sandstone. The Esplanade Sandstone forms a broad bench about 436 feet thick. The Callville Limestone is about 425 feet thick.

Above the Supai Group lies the Permian Hermit Formation (Shale) which intertongues with the underlying Esplanade. The lower 121 feet of the Hermit Formation consists of soft, gypsiferous, red sandstones and siltstones. A 50-foot-thick tongue of Esplanade Sandstone lies above this followed by an approximately 260-foot sequence of reddish-brown to light brown, fine-grained sandstones, siltstones, and claystones. The remaining strata consists of 660 feet of brick-red siltstones and claystones.

Above the Hermit Shale lies about 40 feet of Permian Coconino Sandstone overlain by 383 feet of the Permian Toroweap Formation. The Toroweap Formation consists of a lower sequence of dolostones, gypsum, and red clastics, a middle sequence of cliff-forming limestones, and an upper evaporite, clastic, and carbonate sequence, grading into the overlying Permian Kaibab Formation. The Kaibab consists of approximately 400 feet of cliff-forming, cherty limestone and an upper sequence of limestones, evaporites, and clastics. There are outcroppings of Lower Triassic strata represented by the Moenkopi Formation and of Quaternary basaltic lava flows.

Arizona-Nevada

The portion of Lake Mead west of the Colorado Plateau is transitional between the Grand Canyon sequence and Basin and Range volcanics and conglomerates. Most of the pre-Tertiary section is either missing or similar to formations further to the east. It is apparent that Basin and Range-type extension, faulting, and volcanism began in the Lower Tertiary and reached a maximum in the Miocene.

The Precambrian basement is composed of a lower section of schistose and phyllitic rocks, followed by hornblende-biotite gneiss, biotite-almandine gneiss and schist and garnetiferous granite pegmatite (Anderson, 1978). In many areas the Miocene Patsy Mine Volcanics lies unconformably on the crystalline basement. In the northern part of LAME, east of Iceberg Canyon, Callville Bay and Echo Bay, the Paleozoic is represented by limestone of the Mauve and Pakoon, up to 6,000 feet thick. In the Callville Bay area, about 50 feet of the Tertiary Horse Spring Formation is exposed (Bachhuber and Morris, 1984), although further north in the Overton area, the Paleozoic carbonates are undifferentiated. Where present, the Triassic is represented by subaerial deposition of fluvial and aeolian deposits equivalent to the Moenkopi, Chinle and Kayenta formations.

In the Northshore Road and Overton Beach area, the Jurassic is present as the Aztec Sandstone. The Aztec is a well-sorted, tan to red aeolian sandstone equivalent to the Navajo Sandstone in

Utah. It is fault contact with the undifferentiated carbonates below and the Tertiary Muddy Creek Formation above (Bachhuber and Morris, 1984). Above the Muddy Creek Tertiary volcanics and gravels.

Further to the south, (Boulder City and Black Canyon 15-minute quads) the Precambrian crystalline basement is overlain by Miocene volcanics, with almost the entire Paleozoic and Mesozoic section absent. Anderson (1977) mapped a layer of unfossiliferous gray cherty carbonate, sandstone, and carbonate conglomerate in the River Mountains west of Boulder City as undifferentiated Paleozoic or Mesozoic strata. The Patsy Mine Volcanics (Miocene) lie above these sediment or in contact with the Precambrian.

The Patsy Mine Volcanics consist of over 13,000 feet of lava flows and tuffs. A lower undifferentiated member consists of andesite lavas and breccia. Above this are dark purple-gray andesite flows and breccia. A layer of sedimentary highly, lithified pale-yellow tuff (about 2,700 feet thick) lies above the andesite. The upper member consists of about 1,500 feet of rhyolitic lava and tuffs.

Above the Patsy Mine Volcanics, is the Tuff of Bridge Spring (Miocene) consisting of quartz-free rhyolitic ash-flow tuff about 600 feet thick (Anderson, 1978). Associated with these volcanics are rhyolitic to basaltic dikes, perhaps equivalent to the Fortification Creek Member of the Muddy Creek Formation and the Mount Davis Volcanics.

The Boulder City pluton is a large Miocene intrusive consisting mostly of light gray, fine- to medium-grained pyroxene-bearing quartz monzonite and granodiorite. In the Boulder City 15-minute quadrangle, Anderson (1977) maps two volcanic units between the Boulder City pluton and the Mount Davis Volcanics, both Miocene in age: Volcanic and Intrusive Rocks of the River Mountains and Volcanic Rocks of the McCullough Range. The former (older) consists of mostly rhyodacites and trachyandesite and the latter of andesite and altered andesite. Both are local to those mountain ranges.

The Mount Davis Volcanics are composed mainly of lava flows from basalt to rhyolite, similar to the Patsy Mine volcanics, but with more basalt and less breccia (Anderson, 1977). This unit may be equivalent to the lavas of the River Mountains and the McCullough Range as well as the Golden Door Volcanics of Longwell (1963). In the southeastern part of the Boulder City quadrangle, more than 2,000 feet of lavas are exposed.

The Muddy Creek Formation (Miocene-Pliocene) is mapped by Anderson (1977, 1978) as mostly detritus and conglomerates. In the Black Canyon 15-minute quadrangle, there are four units identified. The lowermost, the Fortification Basalt Member, is composed of basalt lavas intercalated with rocks of the overlying sedimentary members of the Muddy Creek Formation. The lavas are dark gray to black olivine basalts similar to the rocks of the Mount Davis Volcanics. Above this member is a megabreccia made of landslide debris from Precambrian rocks. A lower sedimentary unit consists of a pebble, cobble, and boulder conglomerate and similarly, the upper sedimentary unit is a boulder and cobble conglomerate. The youngest units are Holocene fanglomerates, playa deposits, and alluvium that cover much of the broad desert valleys.

References

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Appendix A
List of Cooperators for Lake Mead NRA GRI Scoping Session
February 13, 2002

LAST NAME	FIRST NAME	TYPE	AFFILIATION	TITLE	PHONE	E-MAIL	Field Trip	Scoping Session
Connors	Tim	Federal	NPS-Geologic Resources Division	Geologist	303-969-2093	Tim_connors@nps.gov	Yes	Yes
Heise	Bruce	Federal	NPS-Geologic Resources Division	Geologist	303-969-2017	Bruce_heise@nps.gov	Yes	Yes
Beard	Sue	Federal	USGS	Geologist	928-556-7196	sbeard@usgs.gov	Yes	Yes
Turner	Kent	Federal	NPS-LAME	Natural Resources	702 293-8941	Kent_turner@nps.gov	No	Yes
Burke	Bill	Federal	NPS-LAME	Natural resources		William_j_burke@nps.gov	Yes	Yes
Bell	Nate	Federal	NPS- LAME	GIS	702 293-8974	Nate_bell@partner.nps.gov	No	Yes
??	Tom	Academic	SCA	biologist			Yes	Yes
Faulds	Jim	State	Nevada Bureau of Mines and Geology	geologist	775-784-6691, ext. 159	jfaulds@unr.edu	No	no
Rocchio	Judy	federal	NPS	USGS liaison	415-427-1431	Judy_rocchio@nps.gov	No	no
Rowland	Steve	Academic	University of Nevada Las Vegas	geologist		srowland@nevada.edu	No	No
Sappington	Mark	Federal	USGS - BRD Cooperative	GIS	702-895-	sapping@nevada.edu	No	No

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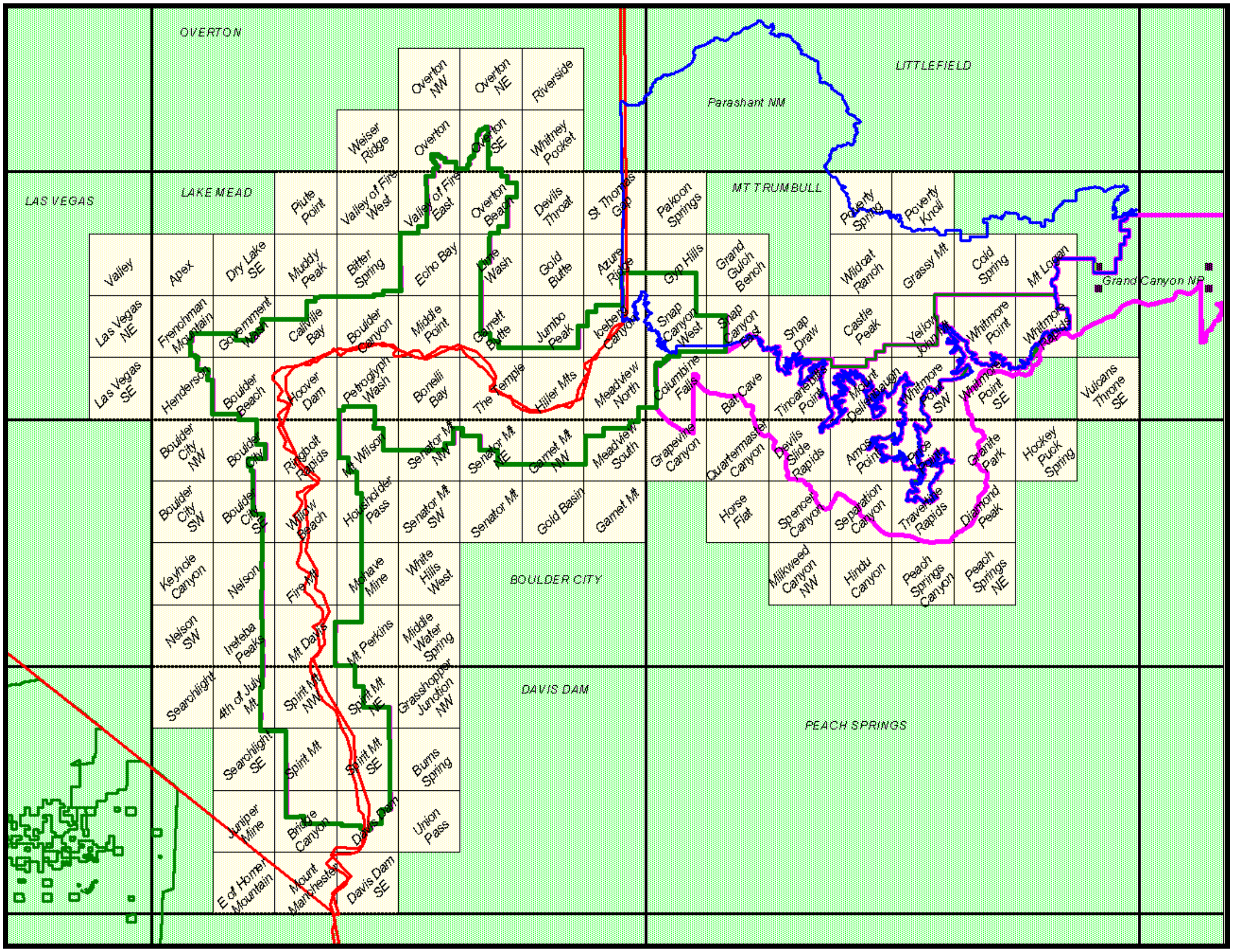
February 13, 2002

LAST NAME	FIRST NAME	TYPE	AFFILIATION	TITLE	PHONE	E-MAIL	Field Trip	Scoping Session
			Studies Unit; Department of Biological Sciences; University of Nevada, Las Vegas		3732			
Hook	Simon	federal	Jet Propulsion Laboratory	Science Project Scientist	818-354-0974	simon.j.hook@jpl.nasa.gov	No	no
Murchey	Bonnie	Federal	USGS	Geologist	415-329-4980	bmurchey@usgs.gov	No	no

Appendix B
LAME park boundary and quadrangles of interest



Appendix B
LAME park boundary and quadrangles of interest

LAME quadrangles of interest						
NPS4	**USGS_NAME**	**State**	**YMin**	**XMin**	**YMax**	**XMax**
LAME	Riverside	NV	36.625	-114.125	36.75	-114.25
LAME	Overton NE	NV	36.625	-114.25	36.75	-114.375
LAME	Overton NW	NV	36.625	-114.375	36.75	-114.5
LAME	Whitney Pocket	NV	36.5	-114.125	36.625	-114.25
LAME	Overton SE	NV	36.5	-114.25	36.625	-114.375
LAME	Overton	NV	36.5	-114.375	36.625	-114.5
LAME	Weiser Ridge	NV	36.5	-114.5	36.625	-114.625
LAME	Poverty Knoll	AZ	36.375	-113.375	36.5	-113.5
LAME	Poverty Spring	AZ	36.375	-113.5	36.5	-113.625
LAME	Pakoon Springs	AZ	36.375	-113.875	36.5	-114
LAME	Saint Thomas Gap	AZ	36.375	-114	36.5	-114.125
LAME	Devils Throat	NV	36.375	-114.125	36.5	-114.25
LAME	Overton Beach	NV	36.375	-114.25	36.5	-114.375
LAME	Valley of Fire East	NV	36.375	-114.375	36.5	-114.5
LAME	Valley of Fire West	NV	36.375	-114.5	36.5	-114.625
LAME	Piute Point	NV	36.375	-114.625	36.5	-114.75
LAME	Mount Logan	AZ	36.25	-113.125	36.375	-113.25
LAME	Cold Spring	AZ	36.25	-113.25	36.375	-113.375
LAME	Grassy Mountain	AZ	36.25	-113.375	36.375	-113.5
LAME	Wildcat Ranch	AZ	36.25	-113.5	36.375	-113.625
LAME	Grand Gulch Bench	AZ	36.25	-113.75	36.375	-113.875
LAME	Gyp Hills	AZ	36.25	-113.875	36.375	-114
LAME	Azure Ridge	AZ	36.25	-114	36.375	-114.125
LAME	Gold Butte	NV	36.25	-114.125	36.375	-114.25
LAME	Lime Wash	NV	36.25	-114.25	36.375	-114.375
LAME	Echo Bay	NV	36.25	-114.375	36.375	-114.5
LAME	Bitter Spring	NV	36.25	-114.5	36.375	-114.625
LAME	Muddy Peak	NV	36.25	-114.625	36.375	-114.75
LAME	Dry Lake SE	NV	36.25	-114.75	36.375	-114.875
LAME	Apex	NV	36.25	-114.875	36.375	-115
LAME	Valley	NV	36.25	-115	36.375	-115.125
LAME	Whitmore Rapids	AZ	36.125	-113.125	36.25	-113.25
LAME	Whitmore Point	AZ	36.125	-113.25	36.25	-113.375
LAME	Yellow John Mountain		36.125	-113.375	36.25	-113.5
LAME	Castle Peak	AZ	36.125	-113.5	36.25	-113.625
LAME	Snap Draw	AZ	36.125	-113.625	36.25	-113.75
LAME	Snap Canyon East	AZ	36.125	-113.75	36.25	-113.875
LAME	Snap Canyon West	AZ	36.125	-113.875	36.25	-114
LAME	Iceberg Canyon	AZ	36.125	-114	36.25	-114.125
LAME	Jumbo Peak	NV	36.125	-114.125	36.25	-114.25
LAME	Garrett Butte	NV	36.125	-114.25	36.25	-114.375
LAME	Middle Point	NV	36.125	-114.375	36.25	-114.5
LAME	Boulder Canyon	NV	36.125	-114.5	36.25	-114.625
LAME	Callville Bay	NV	36.125	-114.625	36.25	-114.75
LAME	Government Wash	NV	36.125	-114.75	36.25	-114.875
LAME	Frenchman Mountain	NV	36.125	-114.875	36.25	-115
LAME	Las Vegas NE	NV	36.125	-115	36.25	-115.125
LAME	Vulcans Throne SE	AZ	36	-113	36.125	-113.125
LAME	Whitmore Point SE	AZ	36	-113.25	36.125	-113.375
LAME	Whitmore Point SW	AZ	36	-113.375	36.125	-113.5

Appendix B
LAME park boundary and quadrangles of interest

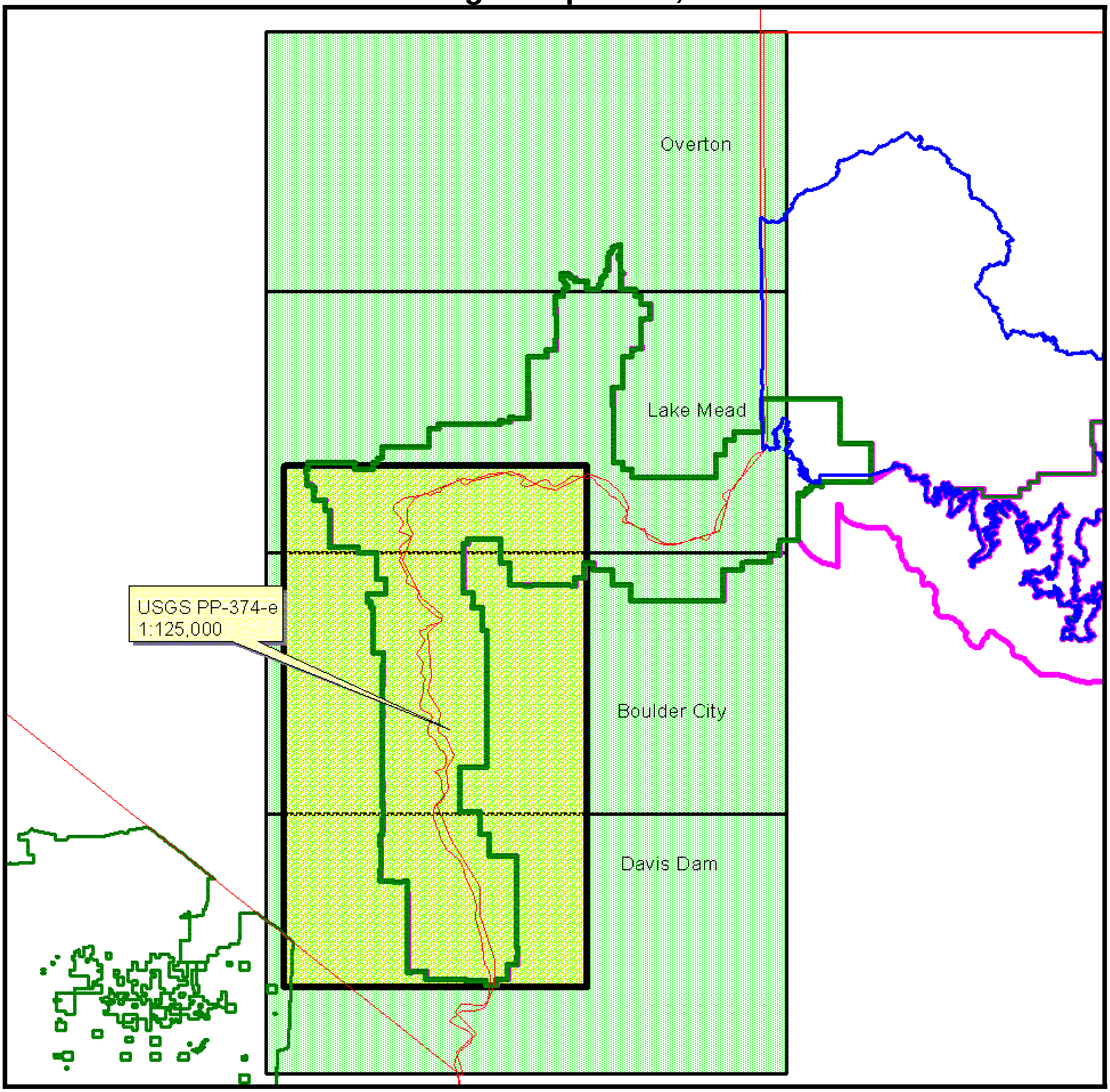
LAME quadrangles of interest

NPS4	USGS_NAME	State	YMin	XMin	YMax	XMax
LAME	Mount Dellenbaugh	AZ	36	-113.5	36.125	-113.625
LAME	Tincanebitts Point	AZ	36	-113.625	36.125	-113.75
LAME	Bat Cave	AZ	36	-113.75	36.125	-113.875
LAME	Columbine Falls	AZ	36	-113.875	36.125	-114
LAME	Meadview North	AZ	36	-114	36.125	-114.125
LAME	Hiller Mountains	NV	36	-114.125	36.125	-114.25
LAME	The Temple	NV	36	-114.25	36.125	-114.375
LAME	Bonelli Bay	AZ	36	-114.375	36.125	-114.5
LAME	Petroglyph Wash	AZ	36	-114.5	36.125	-114.625
LAME	Hoover Dam	AZ	36	-114.625	36.125	-114.75
LAME	Boulder Beach	NV	36	-114.75	36.125	-114.875
LAME	Henderson	NV	36	-114.875	36.125	-115
LAME	Las Vegas SE	NV	36	-115	36.125	-115.125
LAME	Hockey Puck Spring	AZ	35.875	-113.125	36	-113.25
LAME	Granite Park	AZ	35.875	-113.25	36	-113.375
LAME	Price Point	AZ	35.875	-113.375	36	-113.5
LAME	Amos Point	AZ	35.875	-113.5	36	-113.625
LAME	Devils Slide Rapids	AZ	35.875	-113.625	36	-113.75
LAME	Quartermaster Canyon		35.875	-113.75	36	-113.875
LAME	Grapevine Canyon	AZ	35.875	-113.875	36	-114
LAME	Meadview South	AZ	35.875	-114	36	-114.125
LAME	Garnet Mountain NW	AZ	35.875	-114.125	36	-114.25
LAME	Senator Mountain NE	AZ	35.875	-114.25	36	-114.375
LAME	Senator Mountain NW	AZ	35.875	-114.375	36	-114.5
LAME	Mount Wilson	AZ	35.875	-114.5	36	-114.625
LAME	Ringbolt Rapids	AZ	35.875	-114.625	36	-114.75
LAME	Boulder City	NV	35.875	-114.75	36	-114.875
LAME	Boulder City NW	NV	35.875	-114.875	36	-115
LAME	Diamond Peak	AZ	35.75	-113.25	35.875	-113.375
LAME	Travertine Rapids	AZ	35.75	-113.375	35.875	-113.5
LAME	Separation Canyon	AZ	35.75	-113.5	35.875	-113.625
LAME	Spencer Canyon	AZ	35.75	-113.625	35.875	-113.75
LAME	Horse Flat	AZ	35.75	-113.75	35.875	-113.875
LAME	Garnet Mountain	AZ	35.75	-114	35.875	-114.125
LAME	Gold Basin	AZ	35.75	-114.125	35.875	-114.25
LAME	Senator Mountain	AZ	35.75	-114.25	35.875	-114.375
LAME	Senator Mountain SW	AZ	35.75	-114.375	35.875	-114.5
LAME	Housholder Pass	AZ	35.75	-114.5	35.875	-114.625
LAME	Willow Beach	AZ	35.75	-114.625	35.875	-114.75
LAME	Boulder City SE	NV	35.75	-114.75	35.875	-114.875
LAME	Boulder City SW	NV	35.75	-114.875	35.875	-115
LAME	Peach Springs NE	AZ	35.625	-113.25	35.75	-113.375
LAME	Peach Springs Canyon		35.625	-113.375	35.75	-113.5
LAME	Hindu Canyon	AZ	35.625	-113.5	35.75	-113.625
LAME	Milkweed Canyon NW	AZ	35.625	-113.625	35.75	-113.75
LAME	White Hills West	AZ	35.625	-114.375	35.75	-114.5
LAME	Mohave Mine	AZ	35.625	-114.5	35.75	-114.625
LAME	Fire Mountain	AZ	35.625	-114.625	35.75	-114.75
LAME	Nelson	NV	35.625	-114.75	35.75	-114.875
LAME	Keyhole Canyon	NV	35.625	-114.875	35.75	-115

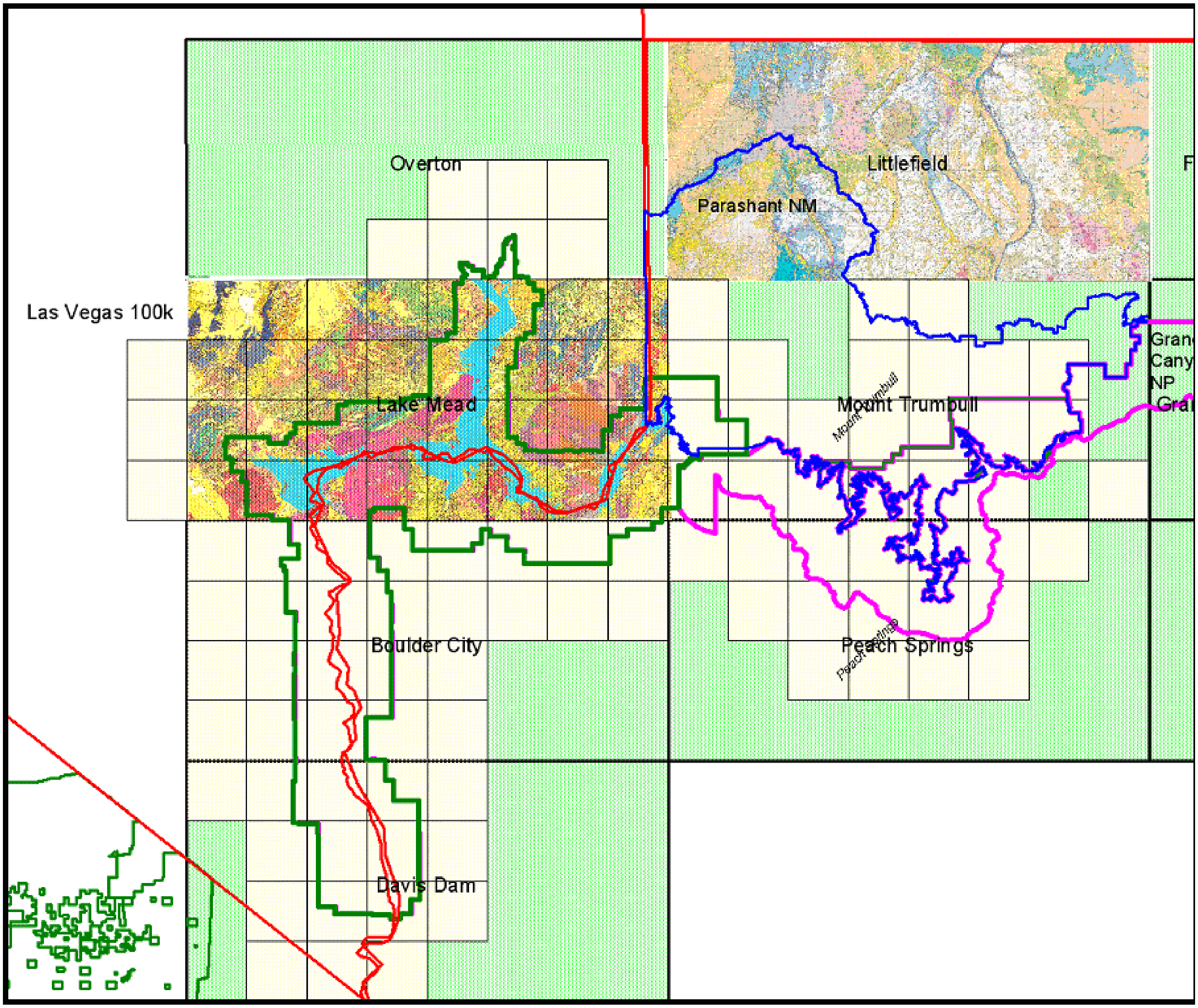
Appendix B
LAME park boundary and quadrangles of interest

LAME quadrangles of interest						
NPS4	**USGS_NAME**	**State**	**YMin**	**XMin**	**YMax**	**XMax**
LAME	Middle Water Spring	AZ	35.5	-114.375	35.625	-114.5
LAME	Mount Perkins	AZ	35.5	-114.5	35.625	-114.625
LAME	Mount Davis	AZ	35.5	-114.625	35.625	-114.75
LAME	Ireteba Peaks	NV	35.5	-114.75	35.625	-114.875
LAME	Nelson SW	NV	35.5	-114.875	35.625	-115
LAME	Grasshopper Junction NW		35.375	-114.375	35.5	-114.5
LAME	Spirit Mountain NE	AZ	35.375	-114.5	35.5	-114.625
LAME	Spirit Mountain NW	NV	35.375	-114.625	35.5	-114.75
LAME	Fourth of July Mountain		35.375	-114.75	35.5	-114.875
LAME	Searchlight	NV	35.375	-114.875	35.5	-115
LAME	Burns Spring	AZ	35.25	-114.375	35.375	-114.5
LAME	Spirit Mountain SE	AZ	35.25	-114.5	35.375	-114.625
LAME	Spirit Mountain	NV	35.25	-114.625	35.375	-114.75
LAME	Searchlight SE	NV	35.25	-114.75	35.375	-114.875
LAME	Union Pass	AZ	35.125	-114.375	35.25	-114.5
LAME	Davis Dam	AZ	35.125	-114.5	35.25	-114.625
LAME	Bridge Canyon	NV	35.125	-114.625	35.25	-114.75
LAME	Juniper Mine	NV	35.125	-114.75	35.25	-114.875
LAME	Davis Dam SE	AZ	35	-114.5	35.125	-114.625
LAME	Mount Manchester	NV	35	-114.625	35.125	-114.75
LAME	East of Homer Mountain		35	-114.75	35.125	-114.875

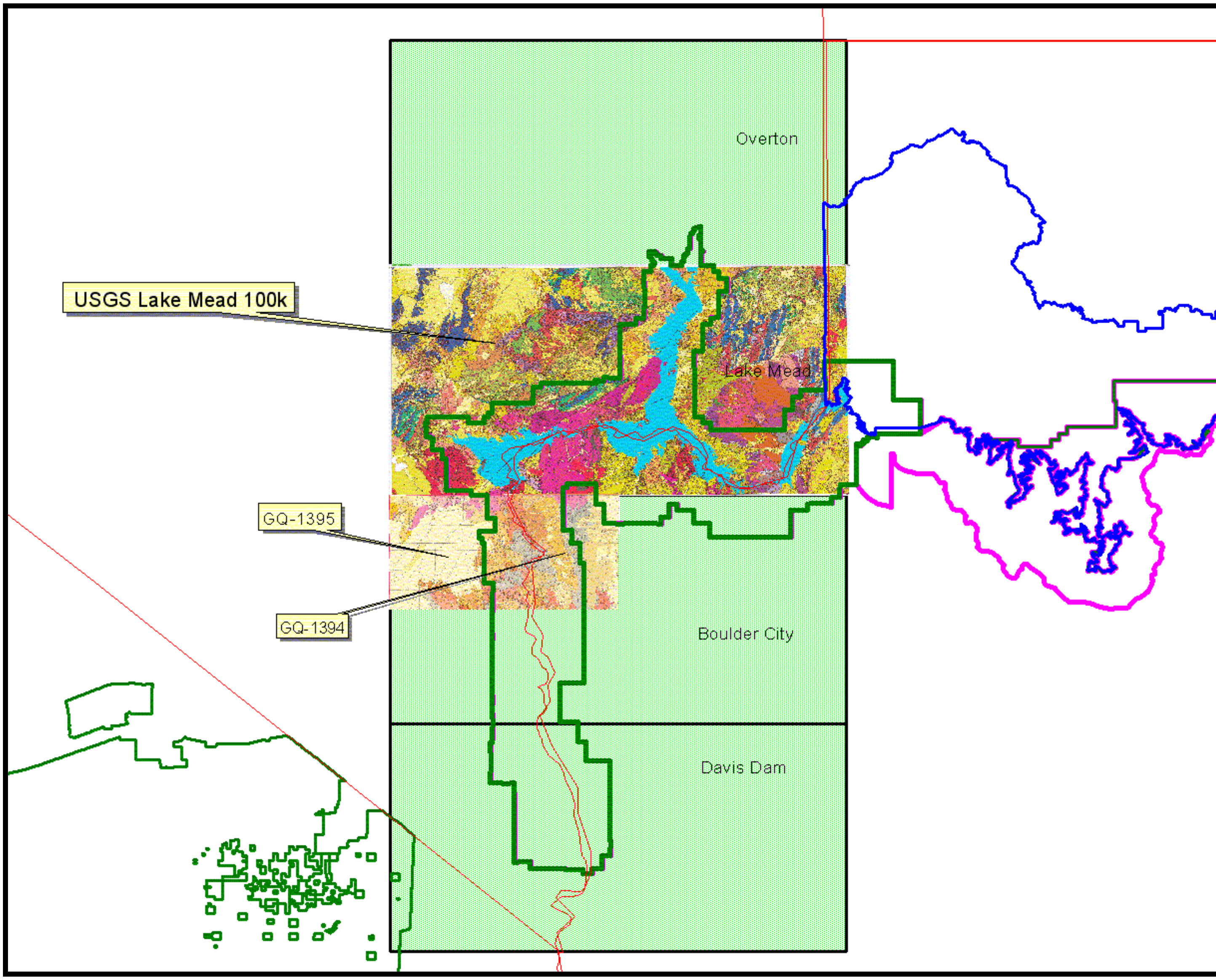
Appendix C
LAME Geologic Maps: *125,000 scale*



Appendix D
LAME Geologic Maps: *100,000 scale*



Appendix E
LAME Geologic Maps: 62*,500 scale*



Appendix F
LAME Geologic Maps: *24,000 scale*